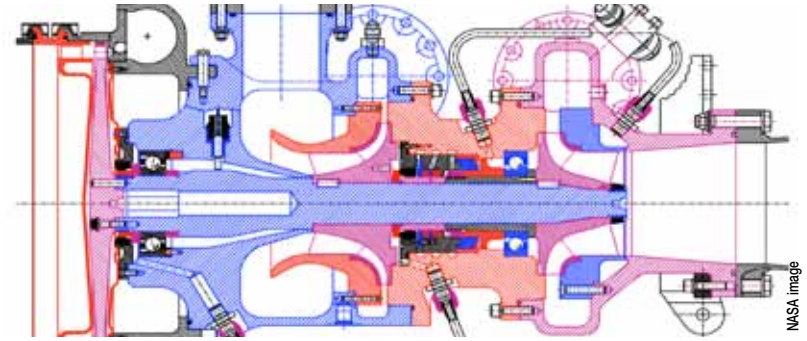
National Aeronautics and Space Administration

GFSSP Benefits Flow Analyses for NASA Missions and Commercial Applications



This diagram shows NASA's Fastrac turbopump analysis as performed by GFSSP.

The image above shows the Fastrac engine turbopump test that was modeled using GFSSP.

In 2001, Concepts NREC licensed NASA's Marshall Space Flight Center's Generalized Fluid System Simulation Program (GFSSP) technology—a general purpose, user-friendly computer program for analyzing steady state and transient flow distribution in complex flow networks. The code allows engineers with backgrounds in fluid mechanics and thermodynamics to quickly and easily develop models for complex flow circuits, such as secondary flows (e.g., leakage flows), to understand the impact of such flows on an entire system. Today, GFSSP is an integral technology in the company's Cooled Turbine Airfoil Agile Design System (CTAADS™) software, marketed to major turbomachinery designers and manufacturers and the aerospace industry.

Benefits of Technology Transfer

Partner Benefits

- Licensing NASA's technology enabled Concepts NREC to integrate it as a key component of the company's CTAADS software.
- Concepts NREC was able to take advantage of NASA's technical investment, avoiding the cost of building a generalized flow analysis program in house, which would have been cost and resource prohibitive.

Technology Benefits

- **Cost-effective:** Enables engineers to build highly accurate models for analysis of fluid flows in complex networks, to understand how the flows will impact performance before costly designs are implemented
- **Efficient:** Provides engineers with the ability to obtain critical performance data at the design stage, to make appropriate design decisions and modifications before resources are committed to manufacturing a system
- **Flexible:** Allows modeling and analysis of individual flow systems and entire complex flow networks
- **Modular:** Offers a generalized structure that enables simple modifications for many applications and future NASA missions in which complex flow networks are present, without the need for expensive code generation or rewriting

success

On the Record

"GFSSP gives design engineers the ability to do a fairly intensive model of internal flows very quickly and easily." *— Katherine VanHooser, Space Shuttle Main Engine Chief Engineer*

"NASA wants to see its technology being utilized by other industries, and GFSSP is an ideal choice for that. It's not limited to turbopumps but can be used for any flow analysis. Because it is a general purpose code, it can be applied to fluid transport systems, models of water flow in pipelines, distribution systems in chemical plants, HVAC systems….It has so much potential as a predictive tool for many industries."*— Dr. Alok Majumdar, GFSSP Innovator, Thermal Analysis Branch, NASA's Marshall Space Flight Center*

"NASA was very easy to work with and interested in seeing its technology commercialized… And GFSSP has been essential for the CTAADS software. It [GFSSP] is the only thing we have that allows us to model the complex internal flows in the turbine blades. Without it, CTAADS would not be a viable product." *— Mark Anderson, Vice President of Software Development, Concepts NREC*

About Concepts NREC

Concepts NREC is a leading independent, full-service turbomachinery design and development corporation with facilities in Wilder, Vermont and Woburn, Massachusetts. The company employs more than 100 professionals and has representatives in the U.S., Africa, Asia, Europe, and the Middle East. Concepts NREC applies turbomachinery technologies to meet evolving applications and provides engineering development, design, prototyping, machining, analysis, and optimization.

Technology Origins

Originally developed as a specific solution for NASA's Propulsion Systems Department to accurately predict the axial thrust in a turbopump, GFSSP has since been modified to work as a modular, general purpose code, enabling modeling designs to be quickly and easily generated for future turbopumps and other components for NASA missions. The program has enabled engineers to save time and avoid the costs associated with writing code from scratch, make better design decisions early on, and decrease the number of tests required while improving testing quality.

GFSSP has been used to model the Fastrac turbopump and is considered the go-to tool for NASA engineers to solve internal flow anomalies involving complex fluid flows. In addition, the technology is currently being used to model the main propulsion system and conduct pressurization and load analyses of the Ares 1 rocket at NASA and the J-2X engine at NASA's Stennis Space Center. At NASA's Kennedy Space Center, GFSSP has been used to model the entire space shuttle loading system, including storage tanks, the propellant tank, and connections to the deck. Such a full-system model was not possible before GFSSP, and it enabled engineers to better predict performance, design more effective testing, and significantly lower design and testing costs.

Finding Application Beyond NASA

For licensee Concepts NREC, GFSSP has become an integral part of the company's CTAADS software, an advanced tool for designing and analyzing actively cooled turbine blades. The company needed a generalized computational method that would enable modeling of the labyrinth of passages and flows inside a turbine blade—a network too complex to be modeled with Computational Fluid Dynamics (CFD)—so it turned to GFSSP. GFSSP offers the unique ability to provide an accurate model of the turbine blade and its flow networks, including flow rates, fluid properties, and contributions of the flow network that impact the blade's temperature. CTAADS was released in 2003 and has become a successful product for the company, with sales to major aerospace organizations.

For More Information

If you would like more information about the GFSSP technology or about other technologies available for licensing, please contact:

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Fuentek is a contractor to NASA's Innovative Partnerships Program, providing support for the access and transfer of technology.